

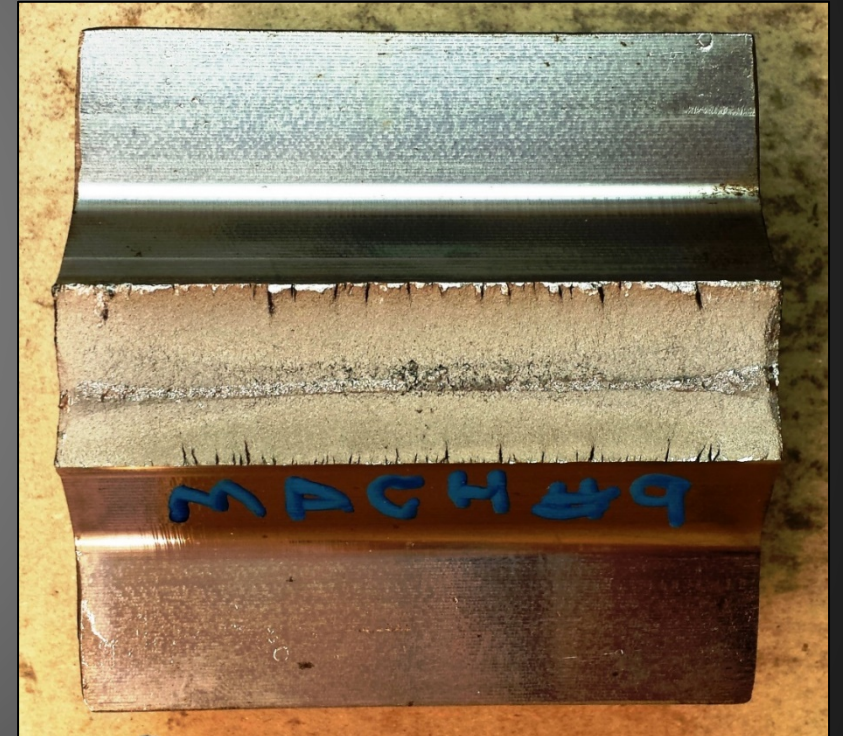
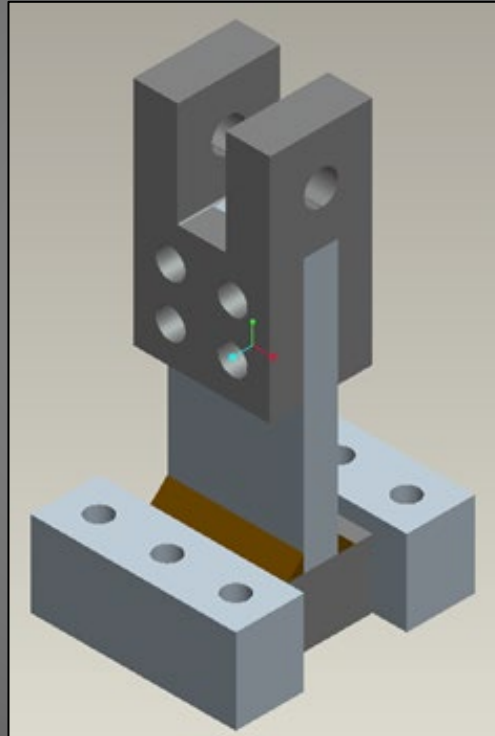
SAE FD&E Residual Stress Committee Update

10/28/2020

Casey Gales

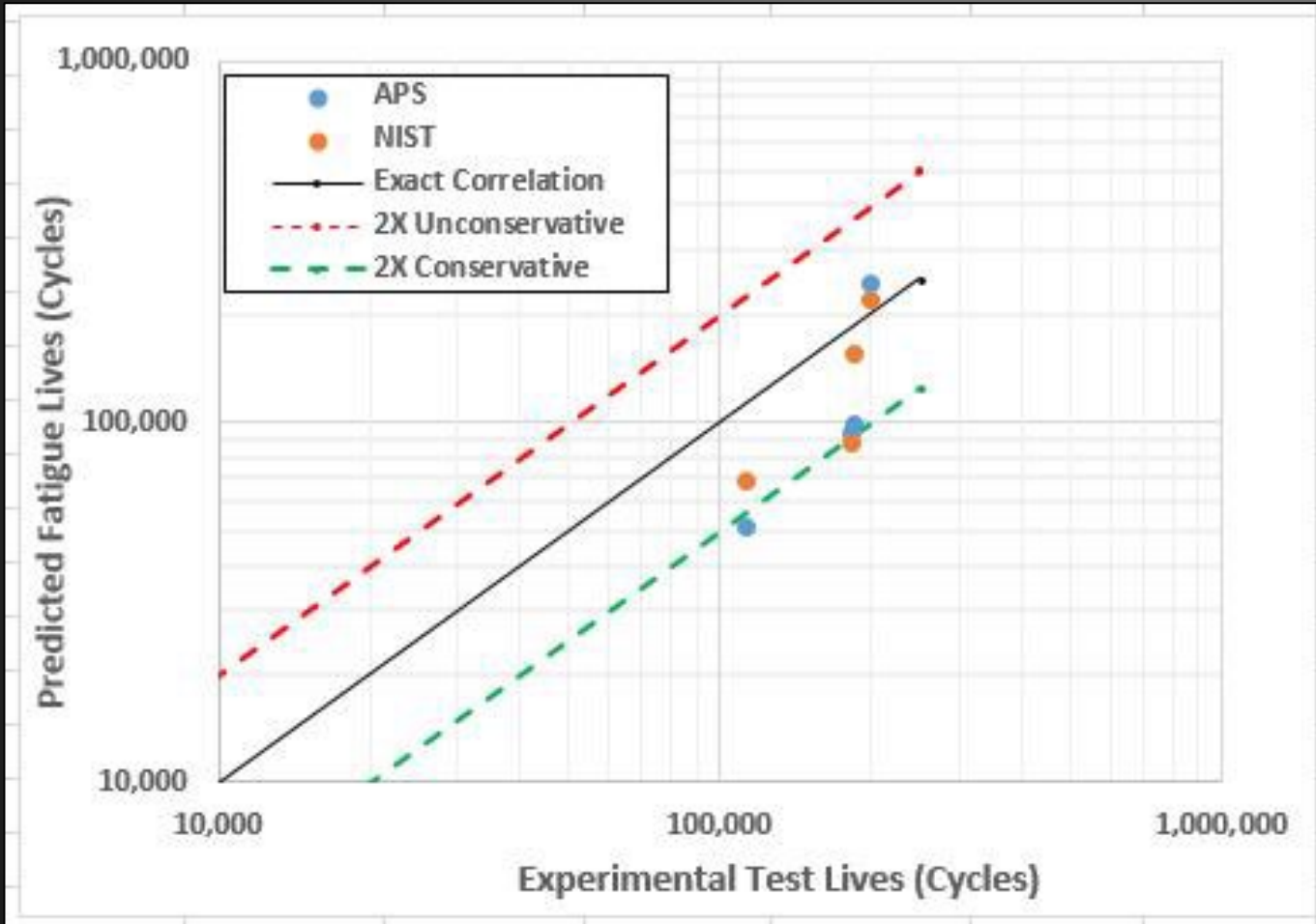
Total Life Recap

- Predict “Total Life”
- Combined Service Life
 - Variable Amplitude
 - Constant Amplitude
- Important Factors
 - Stress Concentration
 - Material Properties
 - Applied Stress
 - Residual Stress
 - And more



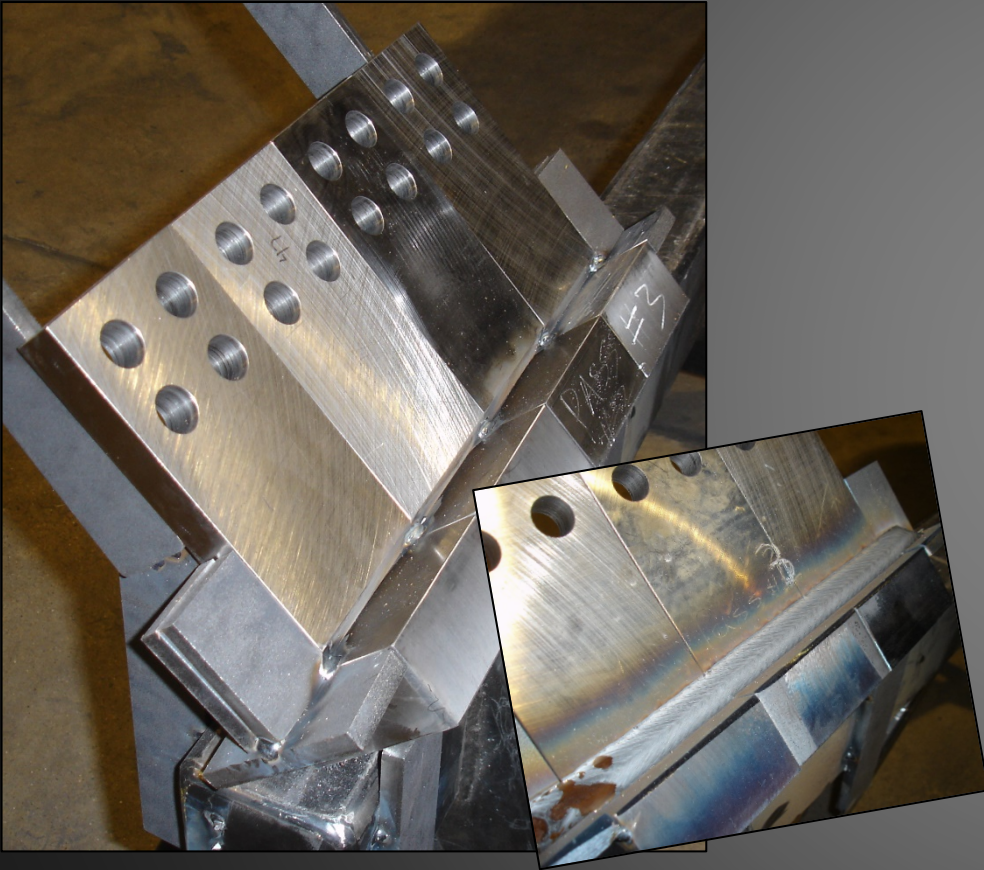
*SAE documentation is available

Importance of Residual Stress



- Two different residual stresses
- NIST shows slightly better correlation
- Both better than no residual stress considered

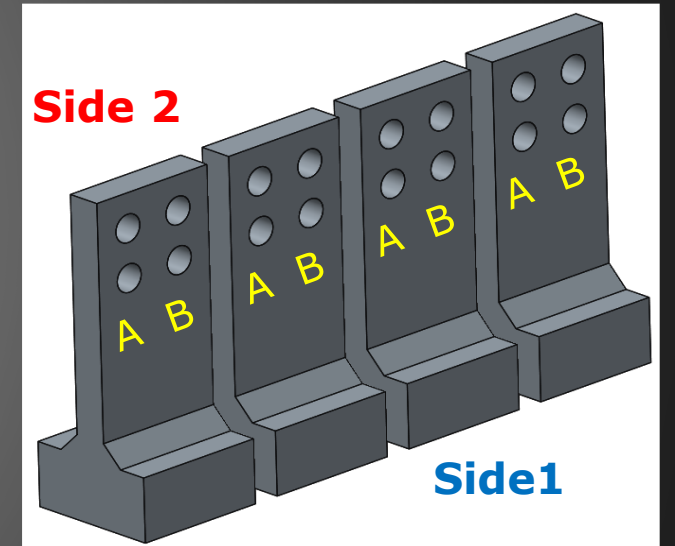
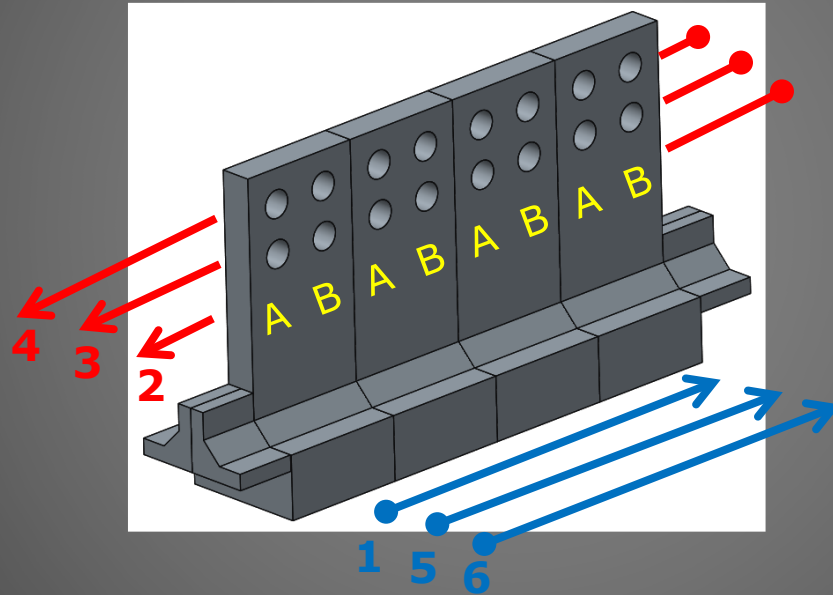
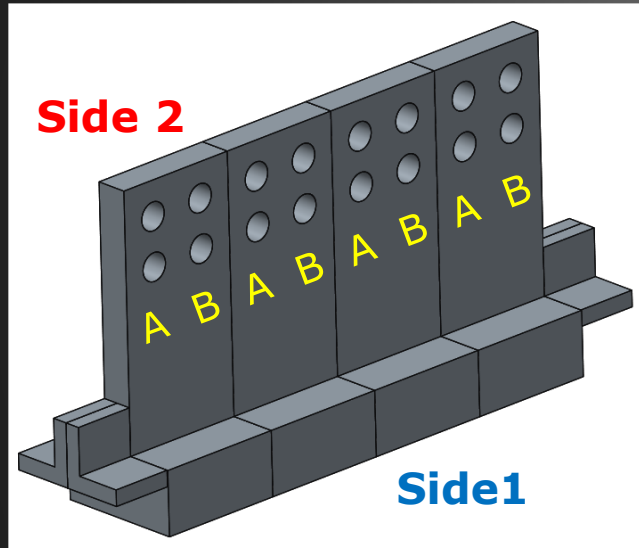
T-Sample Welding Process



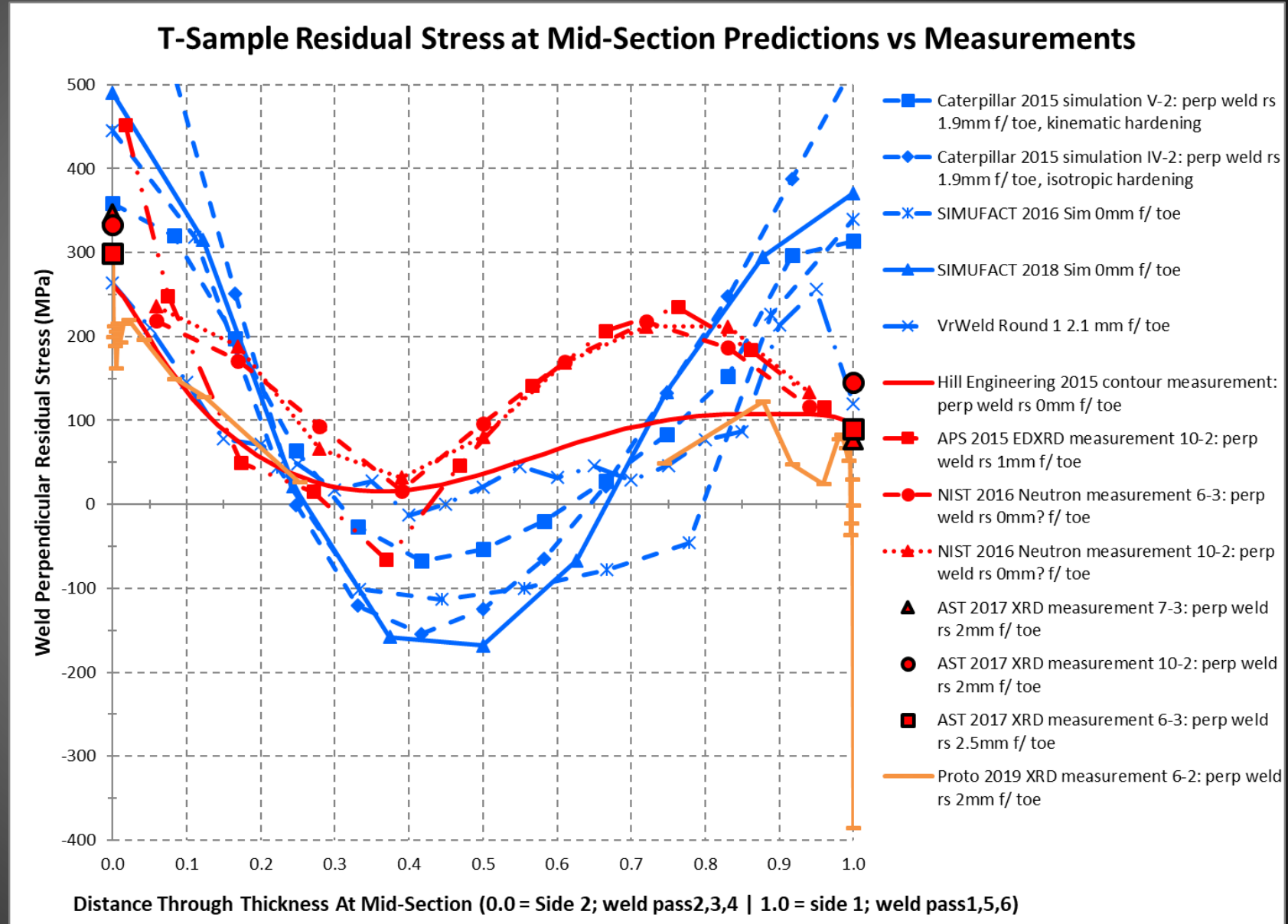
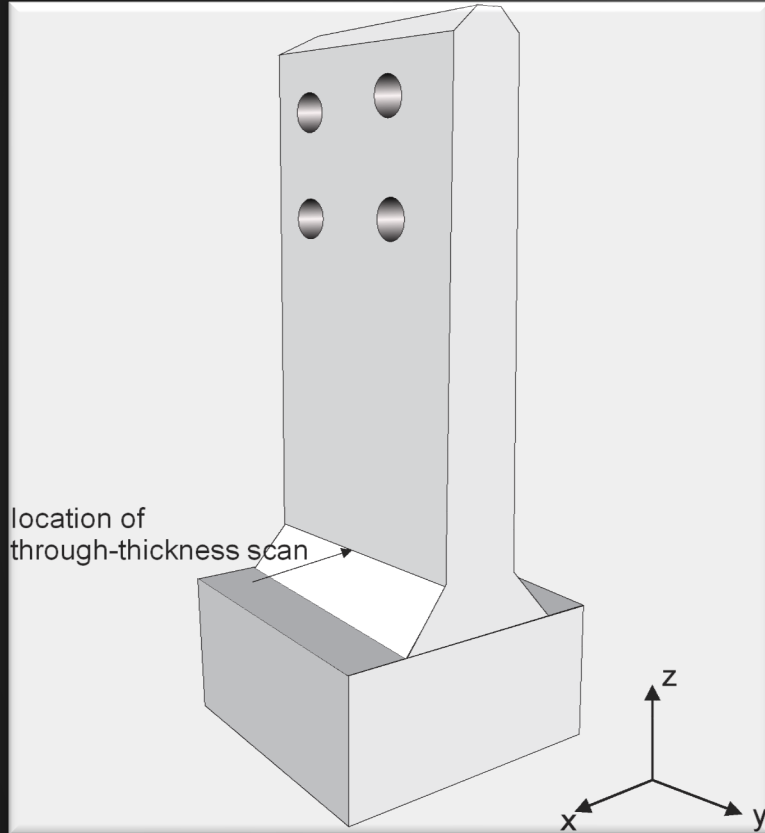
Parameter/Characteristic	Value
Welding Process	GMAW
Wire Type	Solid
Wire Diameter	0.062 inches
Shielding Gas	90% CO2/ 10% Ar
Base Material	A36
Filler Metal	ER70S-6
Welding Position	45 deg for all weld passes

Welding courtesy of John Deere Davenport Works

Welding Process Animation



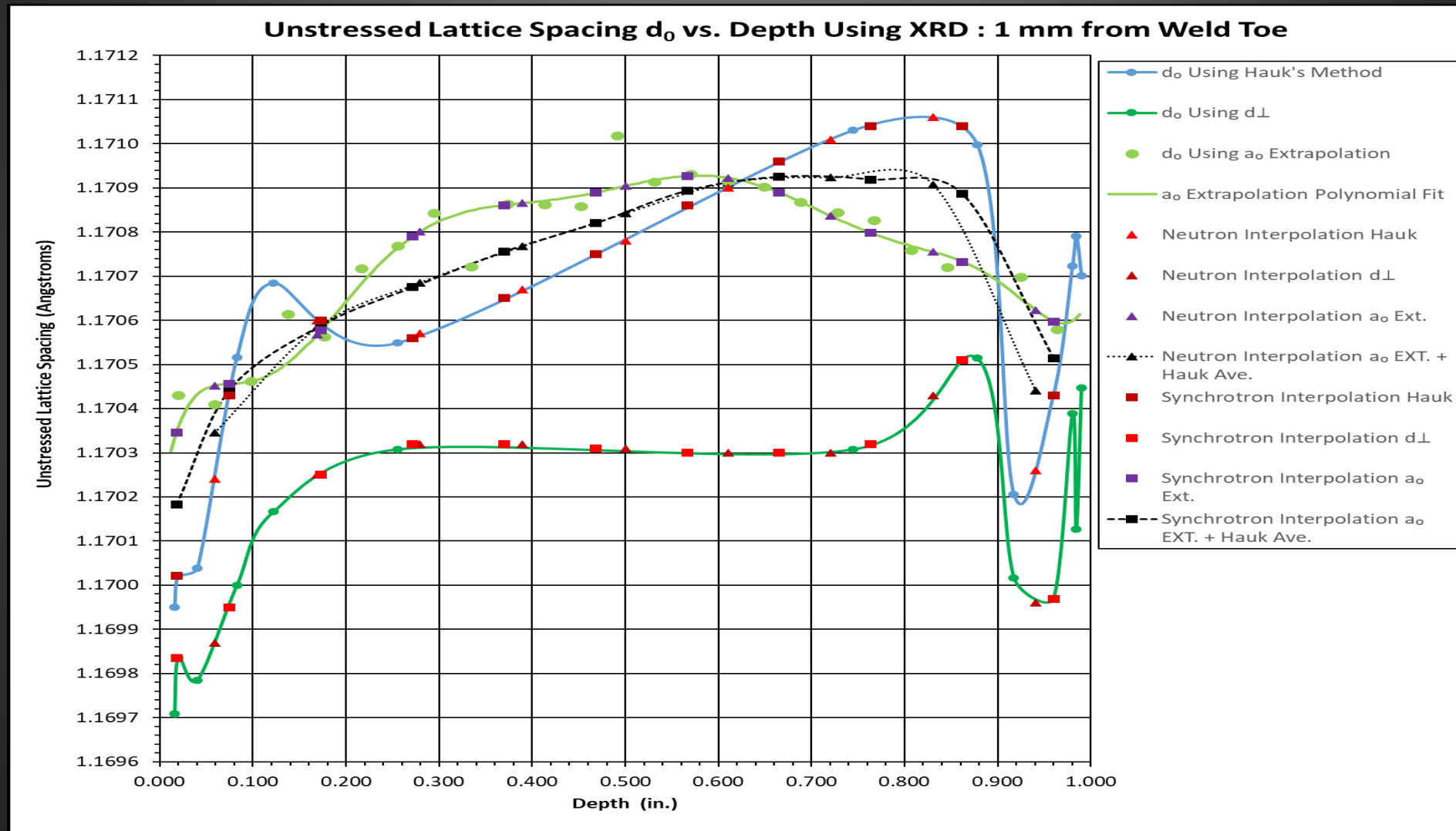
T-Sample Residual Stress



Residual Stress Correlation

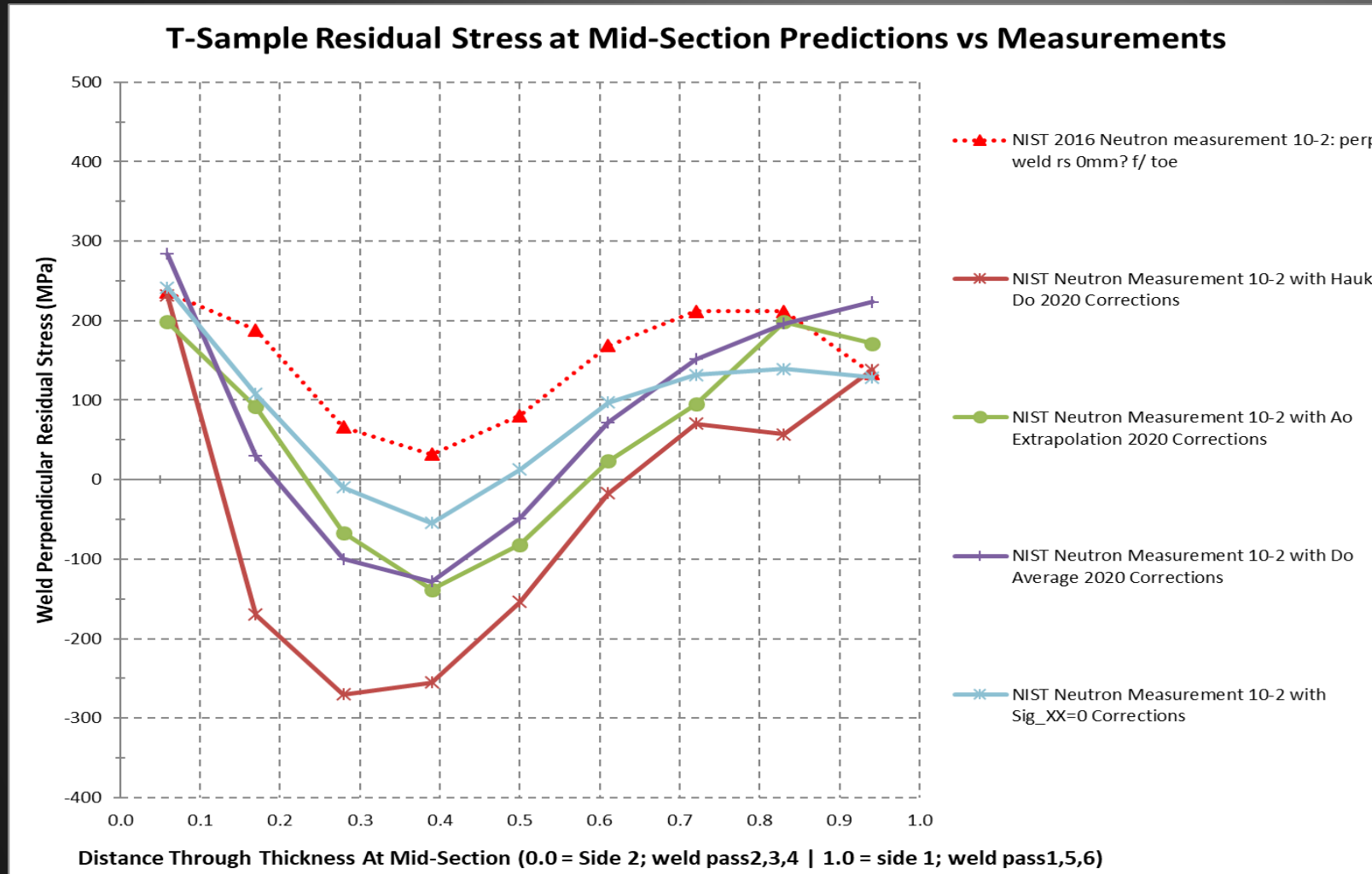
- Measurements and predictions have reasonable group correlation
- Beginning half correlates better
- Most simulations over-predict the ends
- Measured results are calculated based on a constant assumed unstressed lattice spacing (D_0)
 - D_0 varies along measurement plane
 - Can be calculated
 - Hauk
 - a_0 extrapolation
 - $d_{\text{perpendicular}}$

Unstressed Lattice Spacing vs. Depth



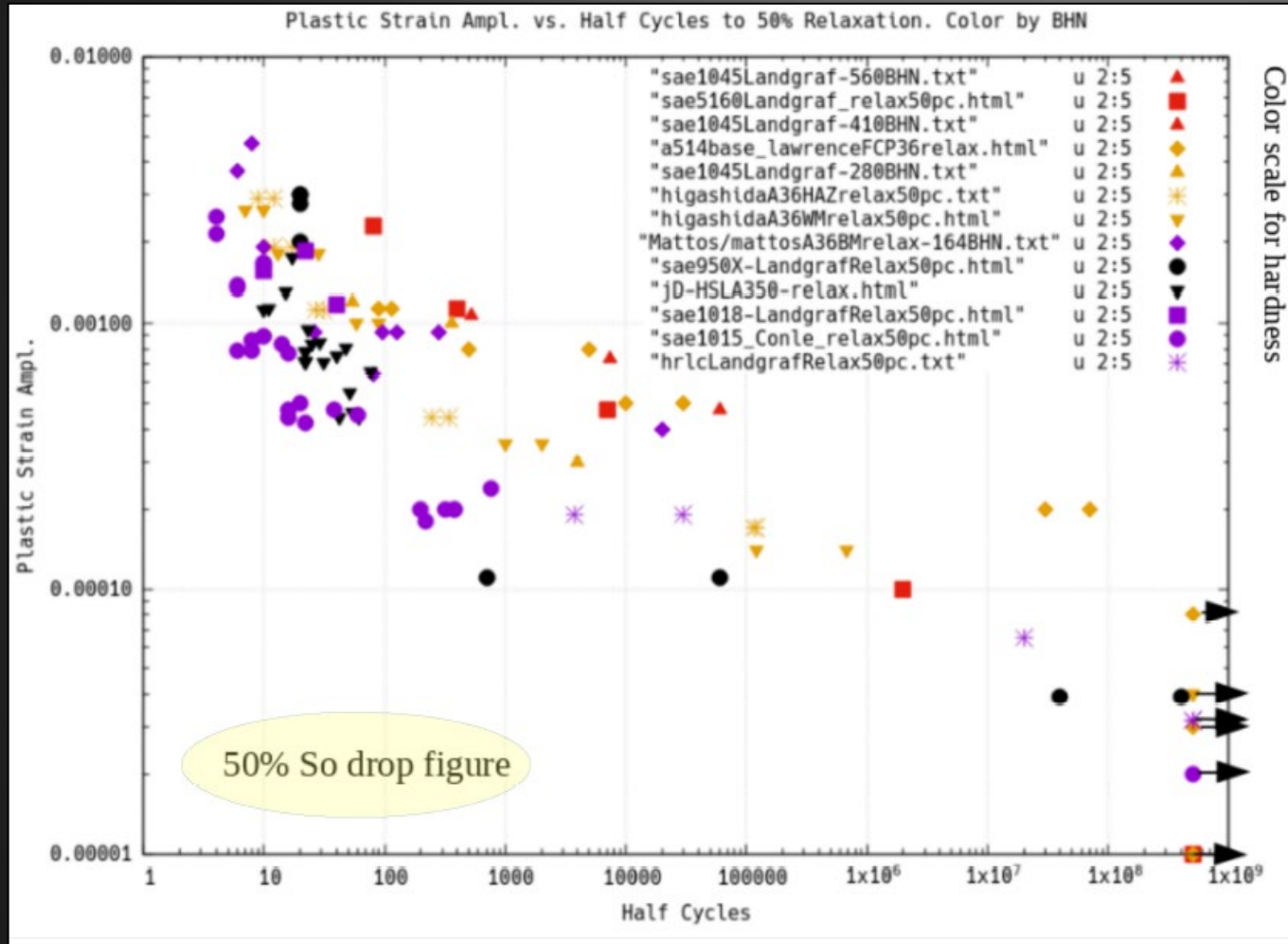
Data/Figures courtesy of ProtoXRD (James Pineault)

Residual Stress Profile with Update Do Data

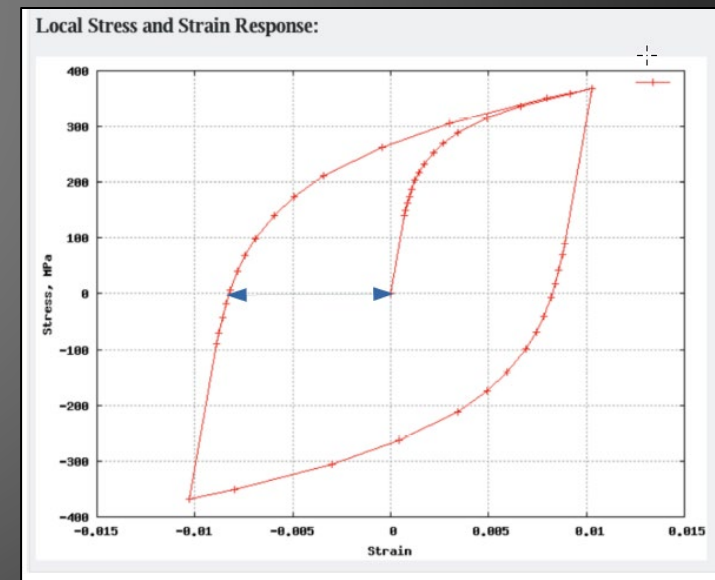


- Red curve is original data
- Colors show the change in RS based on D_0 calculations
- Significantly affects results
- Pursuing direct measurements of D_0 vs thickness

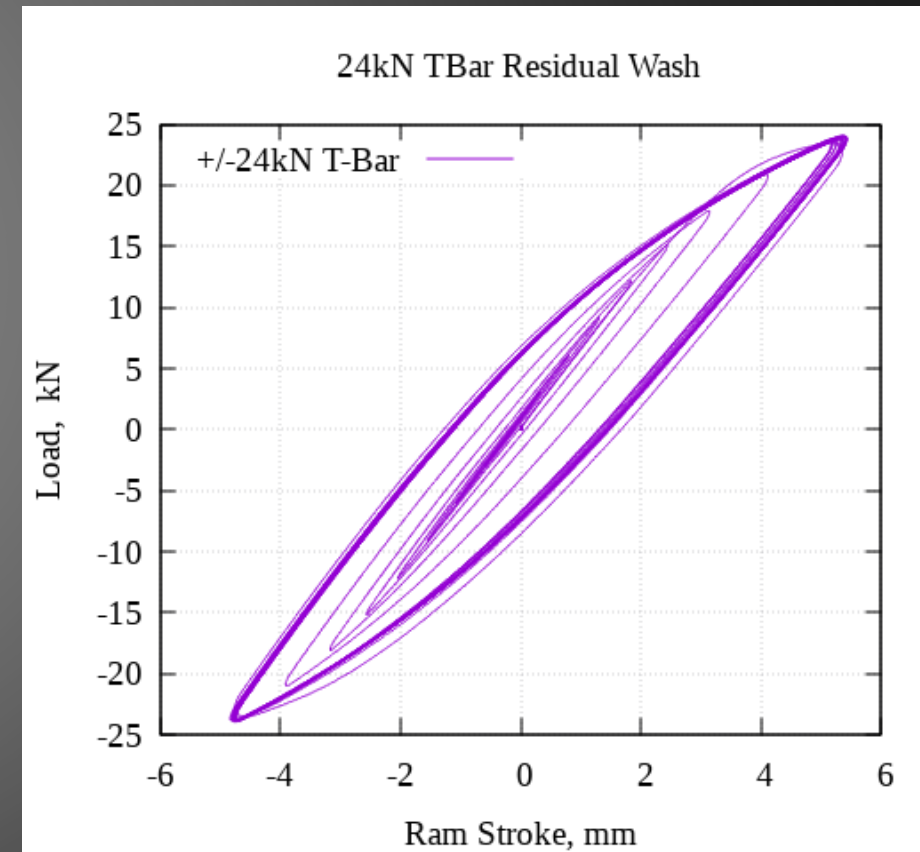
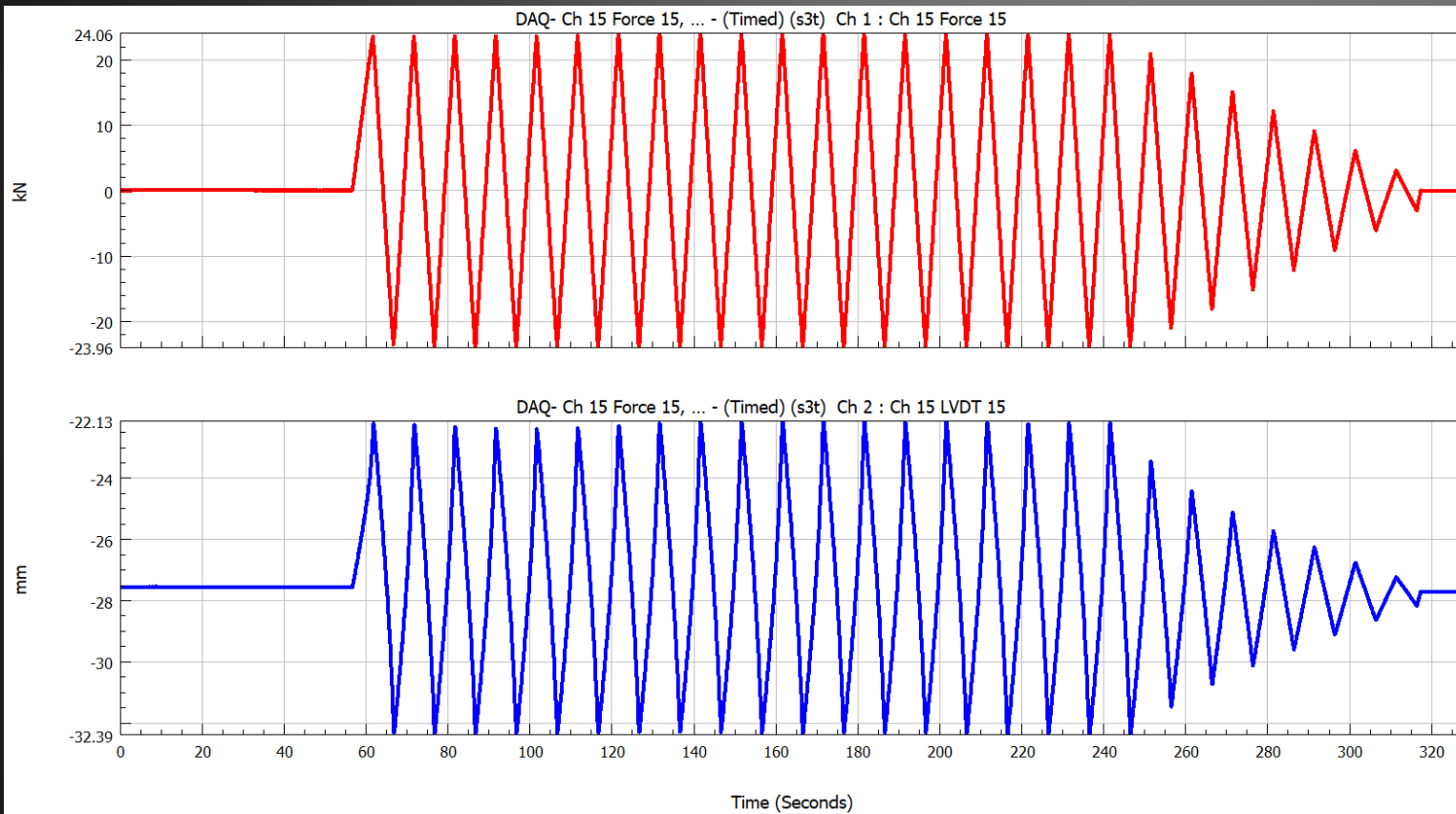
Residual Stress Relaxation Testing



- 24kN load causes plastic strain amplitude of 0.007
- This loop would cause 50% reduction in residual stress in less than 10 cycles

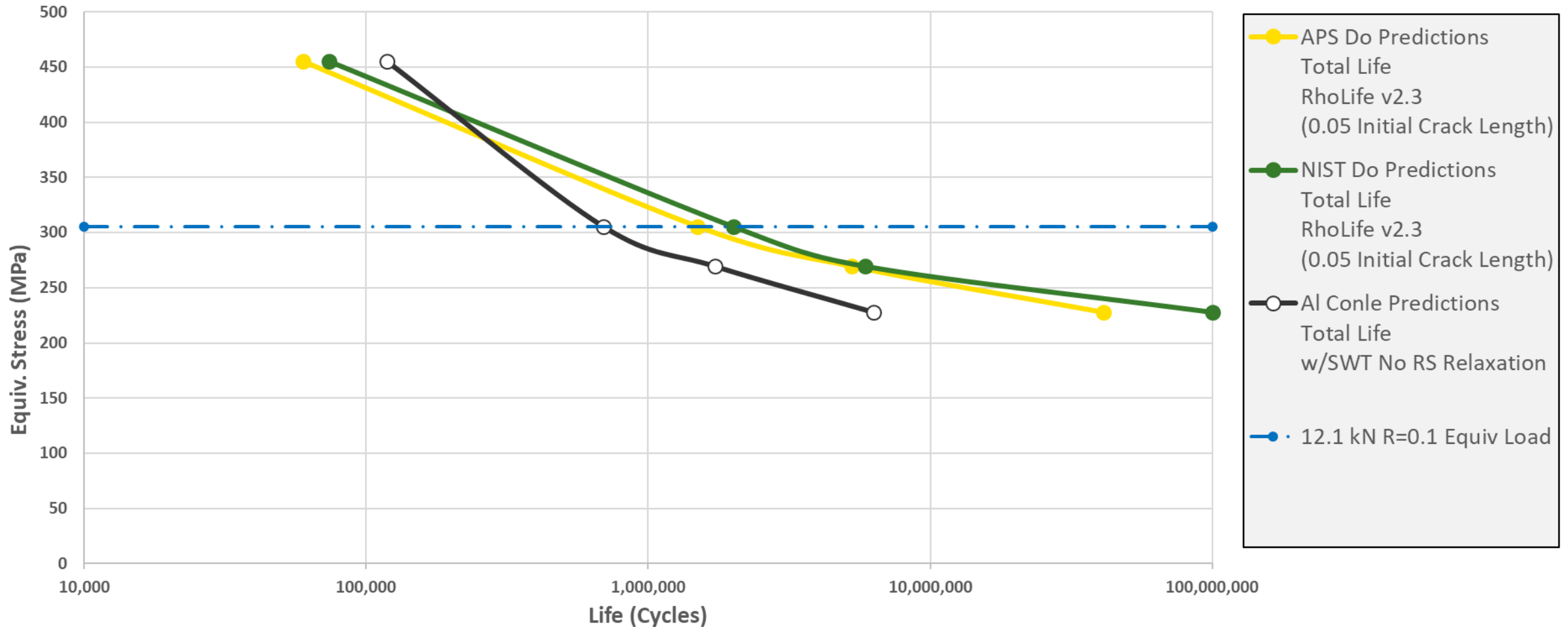


Load Taper and Hysteresis Loop



RS Sensitivity on Total Life Predictions

Total Life Prediction for 12.1kN Load (R = -1, 0.1, 0.3, 0.5)



Future Work

- Measure actual D_0 versus depth and re-calculate RS
 - Work with NIST for neutron data
 - Work with APS for EDD data
- Residual stress relaxation testing
 - Testing different load levels
 - Measure RS post loading
- Fatigue testing samples with modified residual stress
 - Relieved and compressive
 - Predictive work to support testing

Questions

Thank you!

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4/15/2020